

CLAIMS

1. A synchronization tracking apparatus comprising:
 - a replica generation section that performs
 - 5 multicarrier demodulation of a known signal of a received signal and generates a replica;
 - a delay profile generation section that calculates a correlation value between said replica and said received signal and generates a delay profile;
 - 10 an integral value calculation section that integrates said correlation values for each fixed range of said delay profile and calculates a plurality of integral values;
 - a maximum integral value detection section that
 - 15 detects a maximum integral value which is a maximum value of said integral values; and
 - a demodulation timing detection section that detects demodulation timing at which multicarrier demodulation is performed from a position of said maximum
 - 20 integral value.
2. The synchronization tracking apparatus according to claim 1, further comprising:
 - a first detection section that detects a first
 - 25 position at which said correlation value of said delay profile from said delay profile generation section first exceeds a threshold value from a start of said delay profile and generates first position information;

a second detection section that detects a second position at which said correlation value of said delay profile from said delay profile generation section first exceeds said threshold value from an end of said delay
5 profile and generates second position information; and

an interval calculation section that calculates an interval from said first position to said second position based on said first and second position information from said first and second detection sections and generates
10 interval information, and sends that interval information to said integral value calculation section;

wherein said integral value calculation section, within an interval indicated by said interval information, integrates correlation values for each fixed range of
15 said delay profile from said delay profile generation section, calculates a plurality of integral values, and sends that plurality of integral values to said maximum integral value detection section.

20 3. The synchronization tracking apparatus according to claim 1, wherein:

said replica generation section performs multicarrier demodulation of a known signal of a plurality of received signals, generates a replica, and sends that
25 replica to said delay profile generation section; and

said delay profile generation section calculates a correlation value between said replica and said plurality of received signals and generates a plurality

of delay profiles;

said synchronization tracking apparatus further comprising an addition section that adds said plurality of delay profiles from said delay profile generation section and sends a result to said integral value calculation section.

4. The synchronization tracking apparatus according to claim 1,

10 wherein said replica generation section performs multicarrier demodulation of a known signal of a plurality of received signals, generates a replica, and sends that replica to said delay profile generation section;

15 wherein said synchronization tracking apparatus further comprises a selection section that selects a received signal whose reception quality is best from said plurality of received signals and sends that received signal to said delay profile generation section; and

20 wherein said delay profile generation section calculates a correlation value between said replica from said replica generation section and said received signal from said selection section and generates said delay profile.

25 5. The synchronization tracking apparatus according to claim 1, wherein said delay profile generation section comprises:

a correlation value generation part that calculates

a correlation value between said replica from said replica generation section and said received signal;

a thinning-out interval setting part that sets a thinning-out interval; and

5 an in-phase addition part that, when performing in-phase addition of said correlation values from said correlation value generation part, thins out correlation values at said thinning-out interval from said thinning-out interval setting part, performs correlation value in-phase addition, generates a correlation value,
10 and sends that correlation value to said integral value calculation section.

6. The synchronization tracking apparatus according to claim 1, further comprising:
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a delay spread value calculation section that generates a delay spread value indicating a spread of correlation values of said delay profile from said delay profile generation section; and

20 a delay spread value determination section that determines whether said delay spread value is greater than or equal to a reference value and generates a determination result;

wherein said integral value calculation section
25 integrates correlation values for each fixed range of said delay profile and calculates a plurality of integral values when it is indicated by said determination result from said delay spread value determination section that

said delay spread value is greater than or equal to said reference value;

said synchronization tracking apparatus further comprising:

5 a first detection section that detects a first position at which a correlation value of said delay profile first exceeds a threshold value from a start of said delay profile and generates first position information when it is indicated by said determination result that said
10 delay spread value is not greater than or equal to said reference value;

 a second detection section that detects a second position at which a correlation value of said delay profile first exceeds said threshold value from an end of said
15 delay profile and generates first position information when it is indicated by said determination result that said delay spread value is not greater than or equal to said reference value;

 an interval calculation section that calculates an
20 interval from said first position to said second position based on said first and second position information and generates interval information;

 an interval determination section that determines whether an interval indicated by said interval
25 information is greater than or equal to a reference value and generates a determination result;

 a threshold value changing section that changes said threshold value and sends a resulting threshold value

to said first and second detection sections when it is indicated by said determination result from said interval determination section that an interval is greater than or equal to said reference interval; and

5 another demodulation timing detection section that, when it is indicated by said determination result from said interval determination section that said interval is not greater than or equal to said reference interval, receives said first position information from said
10 interval determination section and detects demodulation timing based on said first position of that first position information.

7. The synchronization tracking apparatus according
15 to claim 1, further comprising:

 a delay spread value calculation section that generates a delay spread value indicating a spread of said correlation values of said delay profile from said delay profile generation section; and

20 a delay spread value determination section that determines whether said delay spread value is greater than or equal to a reference value and generates a determination result;

 wherein said integral value calculation section
25 integrates correlation values for each fixed range of said delay profile and calculates a plurality of integral values when it is indicated by said determination result from said delay spread value determination section that

said delay spread value is greater than or equal to said reference value;

said synchronization tracking apparatus further comprising:

5 a maximum peak value detection section that detects a maximum peak value of said correlation values of said delay profile when it is indicated by said determination result that said delay spread value is greater than or equal to a reference value;

10 a first detection section that generates first position information indicating a first position at which said correlation value of said delay profile first becomes greater than or equal to a threshold value in a positive direction which is a direction in which time advances
15 from said maximum peak value;

 a second detection section that generates second position information indicating a second position at which said correlation value of said delay profile first becomes greater than or equal to said threshold value
20 in a negative direction which is a direction in which time is counted backward from said maximum peak value;

 an interval calculation section that calculates an interval from said first position to said second position based on said first and second position information and
25 generates interval information;

 an interval determination section that determines whether said interval indicated by said interval information is greater than or equal to a reference value

and generates a determination result;

5 a threshold value changing section that changes a threshold value and sends a resulting threshold value to said first and second detection sections when it is indicated by said determination result from said interval determination section that said interval is not greater than or equal to said reference interval;

10 a negative direction position storage section that receives said second position information from said threshold value changing section and stores said second position information when it is indicated that said interval is not greater than or equal to said reference interval; and

15 another demodulation timing detection section that, at a time at which a change is made from when it is indicated by said determination result from said interval determination section that said interval is not greater than or equal to said reference interval to when it is indicated that said interval is greater than or equal to said reference interval, reads said second position information of said negative direction position storage section and detects demodulation timing based on said second position of that second position information.

25 8. A synchronization tracking method comprising:

a replica generation step of performing multicarrier demodulation of a known signal of a received signal and generating a replica;

a delay profile generation step of calculating a correlation value between said replica and said received signal and generating a delay profile;

an integration step of integrating said correlation values for each fixed range of said delay profile and calculating a plurality of integral values;

a maximum integral value detection step of detecting a maximum integral value which is a maximum value of said integral values; and

a demodulation timing detection step of detecting demodulation timing at which multicarrier demodulation is performed from a position of said maximum integral value.

9. A synchronization tracking apparatus comprising:

a replica generation section that performs multicarrier demodulation of a known signal of a received signal and generates a replica;

a delay profile generation section that calculates a correlation value between said replica and said received signal and generates a delay profile;

an integral value calculation section that integrates said correlation values for each fixed range of said delay profile and calculates a plurality of integral values;

a maximum integral value detection section that detects a maximum integral value which is a maximum value of said integral values;

a first detection section that detects a first position at which said correlation value of said delay profile from said delay profile generation section first exceeds a threshold value from a start of said delay profile in said fixed range in which said maximum integral value is calculated and generates first position information;

a second detection section that detects a second position at which said correlation value of said delay profile from said delay profile generation section first exceeds said threshold value from an end of said delay profile in said fixed range in which said maximum integral value is calculated and generates second position information;

an interval calculation section that calculates an interval from said first position to said second position based on said first and second position information and generates interval information; and

a demodulation timing detection section that detects demodulation timing based on said interval information.

10. The synchronization tracking apparatus according to claim 9, wherein said demodulation timing detection section comprises:

an interval determination part that receives said first and second position information and said interval information from said interval calculation section, determines whether said interval indicated by said

interval information is greater than or equal to a reference value, and generates a determination result;

a threshold value changing part that changes said threshold value and sends a resulting threshold value
5 to said first and second detection sections when it is indicated by said determination result from said interval determination part that said interval is greater than or equal to said reference interval; and

a demodulation timing detection part that, when it
10 is indicated by said determination result from said interval determination part that said interval is not greater than or equal to said reference interval, receives said first position information from said interval determination part and detects demodulation timing based
15 on said first position of that first position information.

11. The synchronization tracking apparatus according to claim 9, wherein:

said replica generation section performs
20 multicarrier demodulation of a known signal of a plurality of received signals, generates a replica, and sends that replica to said delay profile generation section; and

said delay profile generation section calculates a correlation value between said replica and said
25 plurality of received signals and generates a plurality of delay profiles;

said synchronization tracking apparatus further comprising an addition section that adds said plurality

of delay profiles from said delay profile generation section and sends a result to said integral value calculation section.

5 12. The synchronization tracking apparatus according to claim 9,

wherein said replica generation section performs multicarrier demodulation of a known signal of a plurality of received signals, generates a replica, and sends that
10 replica to said delay profile generation section;

wherein said synchronization tracking apparatus further comprising a selection section that selects a received signal whose reception quality is best from said plurality of received signals and sends that received
15 signal to said delay profile generation section; and

wherein said delay profile generation section calculates a correlation value between said replica from said replica generation section and said received signal from said selection section and generates said delay
20 profile.

13. The synchronization tracking apparatus according to claim 9, wherein said delay profile generation section comprises:

25 a correlation value generation part that calculates said correlation value between said replica from said replica generation section and said received signal;

a thinning-out interval setting part that sets a

thinning-out interval; and

an in-phase addition part that, when performing in-phase addition of said correlation values from said correlation value generation part, thins out correlation values at said thinning-out interval from said thinning-out interval setting part, performs correlation value in-phase addition, generates a correlation value, and sends that correlation value to said integral value calculation section.

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14. A synchronization tracking method comprising:

a replica generation step of performing multicarrier demodulation of a known signal of a received signal and generating a replica;

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a delay profile generation step of calculating a correlation value between said replica and said received signal and generating a delay profile;

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an integral value calculation step of integrating said correlation values for each fixed range of said delay profile and calculating a plurality of integral values;

a maximum integral value detection step of detecting a maximum integral value which is a maximum value of said integral values;

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a first detection step of having a first detection section detect a first position at which said correlation value of said delay profile first exceeds a threshold value from a start of said delay profile in said fixed range in which said maximum integral value is calculated,

and generate first position information;

5 a second detection step of having a second detection section detect a second position at which said correlation value of said delay profile first exceeds said threshold value from an end of said delay profile in said fixed range in which said maximum integral value is calculated, and generate second position information;

10 an interval calculation step of calculating an interval from said first position to said second position based on said first and second position information and generating interval information, and sending that interval information to said integral value calculation section;

15 an interval determination step of determining whether an interval indicated by said interval information is greater than or equal to a reference value and generating a determination result;

20 a threshold value changing step of changing said threshold value and sending a resulting threshold value to said first and second detection sections when it is indicated by said determination result in said interval determination step that said interval is greater than or equal to said reference interval; and

25 a demodulation timing detection step of, when it is indicated by said determination result in said interval determination step that said interval is not greater than or equal to said reference interval, receiving said first position information and detecting demodulation timing

based on said first position of that first position information.

15. A synchronization tracking apparatus comprising:

5 a replica generation section that performs multicarrier demodulation of a known signal of a received signal and generates a replica;

 a delay profile generation section that calculates a correlation value between said replica and said received
10 signal and generates a delay profile;

 an integral value calculation section that integrates said correlation values for each fixed range of said delay profile and calculates a plurality of integral values;

15 a maximum integral value detection section that detects a maximum integral value which is a maximum value of said integral values;

 a maximum peak value detection section that detects a maximum peak value of said correlation values in said
20 fixed range in which said maximum integral value is calculated;

 a positive direction position detection section that detects a first position at which said correlation value first exceeds a threshold value in a positive
25 direction which is a direction in which time advances from said maximum peak value in said fixed range in which said maximum integral value is calculated, and generates first position information;

a negative direction position detection section that detects a second position at which said correlation value first exceeds said threshold value in a negative direction which is a direction in which time is counted backward from said maximum peak value in said fixed range in which said maximum integral value is calculated, and generates second position information;

an interval calculation section that calculates an interval from said first position to said second position based on said first and second position information and generates interval information; and

a demodulation timing detection section that detects demodulation timing based on said interval information and said second position information.

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16. The synchronization tracking apparatus according to claim 15, wherein said demodulation timing detection section comprises:

an interval determination part that receives said first and second position information and said interval information from said interval calculation section, determines whether said interval indicated by said interval information is greater than or equal to a reference value, and generates a determination result;

a threshold value changing part that changes said threshold value and sends a resulting threshold value to said positive direction position detection section and negative direction position detection section when

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it is indicated by said determination result from said interval determination part that said interval is not greater than or equal to said reference interval;

5 a negative direction position storage part that receives said second position information from said threshold value changing part and stores said second position information when it is indicated that said interval is not greater than or equal to said reference interval; and

10 a demodulation timing detection part that, at a time at which a change is made from when it is indicated by said determination result from said interval determination part that said interval is not greater than or equal to said reference interval to when it is indicated
15 that said interval is greater than or equal to said reference interval, reads said second position information of said negative direction position storage part and detects demodulation timing based on said second position of that second position information.

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17. The synchronization tracking apparatus according to claim 15, wherein:

said replica generation section performs multicarrier demodulation of a known signal of a plurality
25 of received signals, generates a replica, and sends that replica to said delay profile generation section; and

said delay profile generation section calculates a correlation value between said replica and said

plurality of received signals and generates a plurality of delay profiles;

said synchronization tracking apparatus further comprising an addition section that adds said plurality of delay profiles from said delay profile generation section and sends a result to said integral value calculation section.

18. The synchronization tracking apparatus according to claim 15,

wherein said replica generation section performs multicarrier demodulation of a known signal of a plurality of received signals, generates a replica, and sends that replica to said delay profile generation section;

15 wherein said synchronization tracking apparatus further comprises a selection section that selects a received signal whose reception quality is best from said plurality of received signals and sends that received signal to said delay profile generation section; and

20 wherein said delay profile generation section calculates said correlation value between said replica from said replica generation section and said received signal from said selection section and generates a delay profile.

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19. The synchronization tracking apparatus according to claim 15, wherein said delay profile generation section comprises:

a correlation value generation part that calculates said correlation value between said replica from said replica generation section and said received signal;

5 a thinning-out interval setting part that sets a thinning-out interval; and

an in-phase addition part that, when performing in-phase addition of said correlation values from said correlation value generation part, thins out correlation values at said thinning-out interval from said
10 thinning-out interval setting part, performs correlation value in-phase addition, generates a correlation value, and sends that correlation value to said integral value calculation section.

15 20. A synchronization tracking method comprising:

a replica generation step of performing multicarrier demodulation of a known signal of a received signal and generating a replica;

20 a delay profile generation step of calculating a correlation value between said replica and said received signal and generating a delay profile;

an integral value calculation step of integrating said correlation values for each fixed range of said delay profile and calculating a plurality of integral values;

25 a maximum integral value detection step of detecting a maximum integral value which is a maximum value of said integral values;

a maximum peak value detection step of detecting

a maximum peak value of said correlation values in said fixed range in which said maximum integral value is calculated;

5 a positive direction position detection step of detecting a first position at which said correlation value first exceeds a threshold value in a positive direction which is a direction in which time advances from said maximum peak value in said fixed range in which said maximum integral value is calculated, and generating first
10 position information;

a negative direction position detection step of detecting a second position at which said correlation value first exceeds said threshold value in a negative direction which is a direction in which time is counted
15 backward from said maximum peak value in said fixed range in which said maximum integral value is calculated, and generating second position information;

an interval calculation step of calculating an interval from said first position to said second position
20 based on said first and second position information and generating interval information; and

a demodulation timing detection step of detecting demodulation timing based on said interval information and said second position information.